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The following information was lifted from the documentation that was submitted by the applicant

Variable optical differential delay conductor line

The invention isc oncernedw itha v ariable opticald ifferentiald elay conductorl inet hati s equipped witha wavec onductor linel oop, and witha wave conductor lineB ragg Screen that possessesa locationv ariable screen constant. Byme anso f extending slight influences ontot he screeni t ist o create tremendousr un timel engthd ifferences between the lightp ortions ofo rthogonally polarizedp olarizationc onditions. W ith differential delay conductorl ineso f this kind,i ti sp ossiblet oc ompensates pecificallyfo rt he polarization moded ispersions of opticalfib erc onductors.

Description

Thep resentedi nventioni sc oncerned witha no ptical differential delay conductor linet hat allowsf ora v ariable delay of the orthogonalp olarizedp ortions of the light ray,a ndt o subsequently putting it together insideo fa w avec onductor. H erewith, it is possiblet o variable adjust the group runningt ime difference betweent hep ortions that are int he polarization conditions.

Delayc onductorl ines arec ommonlya chievedi na free ray configurationb ym eanso f componentst hata re ablet om echanically slide. According to theo pen laying document DE 197 17 457A 1o f the GermanP atent Office,t herea rea lsov ariabled elay conductor lines known that possessw ave conductorlin es ands o calledc hirpedB ragg Screens. Arrangements ofs ucha kindc anb e achieved eitherw itht he support of polarization dividing components, or also bym eanso fd ifferentiald elayc onductor lines.

Thes copeo f thep resented inventioni s to achievea n opticalw ave conductor differential delayc onductor line thatp ossessesa c ompact construction,a ndt hath as principally low losses,a nd itsb asev ersion is able to functionw itha single reversiblem odifiablew ave conductor screen,a nd that allowsf ora rapida djustment oft he desiredr un time differences, andt hats pecificallya lsoa llows for as ubsequent connection(c ascading) of severalw avele ngthc omponents.

According to thei nvention, thiss copei ss olved bys uchm eanst hat ani ncomingli ght floww ill bed ivided into twop ortionst hat areo rthogonal polarized to eacho ther. T his division will be executedb ym eanso f ad irectional four-gate polarizationc oupler. Said divided portionsa rec oupled contrad irectionallyi nto aw avec onductorl oopt hat connects thet woe xitg ates of thed irectional coupler. A w avec onductorB raggS creent hat possesseslo cation variables creen constants("chirpeds creen")is l ocated inside this loop, and it reflects eacho f thet wop artiall ightf lowso f aw avel ength channel. T he arrangement is designed bym eans byp olarizationo pticale lementsi ns ucha way that thoser eflected portionse xit thed irectional coupler throught he fourthg ate. By means of thet uning oft he Bragg Screeni na m anner asi ti sd escribedi n thea bovem entioned open layingd ocumentD E1 97 17 457A 1 oft heG ermanP atentO ffice –f ore xample, by means of slight stretching –i t is possible to movet hee ffective reflectionp oint within the screenc onsiderably. Herewith,a differentialr un lengthe xtensionr esultsf rom the contra directionalp atho f the light, whichi s equalt o doublet hem ovement oft her eflection point. Af urther wavelength channelw hichis notr eflectedb yt hef irsts creen can bet reated in the samem annerb y means ofa s econd BraggS creenc onnectedi n as eries. T he medianw avelength oft her eflectiono f the second screeni s orienteda t the median wavelength of the secondc hannel. I t'sr eflections pectrum should bed esigned in sucha manner that ito verlaps only minimallyw itht her eflection spectrum of thef irsts creen. Furtherw avelengthc hannelsc anb e consideredi na similarm anner. F ort hec aset hat variousw ave lengthc hannelsa re separatedi nto different polarization conditions,i ti s possiblet hatd ifferentw avec onductor loopst hate achc ontaino nly onec ertainB ragg Screenf or eachw ave lengthc hannel,a nd are cascaded bym eans of interconnecting polarization adjusters. Herewith,b yu tilizingp olarizationc omponents,t he single loops havet o be designed ins uch af ashion thatt he non-reflected portions will exitt he directionalc ouplera lso att he fourthg ate. I t isp ossibleh erewith, thatd ifferentl oopst hat aret o beu tilizedf ort hes ame wave length channelc an bec onnected consecutively in thes amem anner.B ecauseo f thisf actit is p ossible,fo re xample,t o achieve

compensations of ah igherd egreew itht hec ompensation of polarization mode dispersion.F oro ther applications,i t iso fa dvantaget o back couplet he non-reflected portionsi nto thef eeding wavec onductorl ine. Thism odeo fo perationc ana lso be achievedb y means oft he supporto f polarization optical elements int he loop.

The chromatic dispersiont hat isc ausedb yt he chirped Bragg Screens canb en eglected form osto ft hec ases.In g eneral, thed imensiono fs aidch romaticd ispersionis liket he one ofa fewk ilometers of standard fibersa t wavelengths of 1550 nm. F or the case that noa dditionalc hromaticd ispersion isd esired, thisc anb e achieved bym eans of the subsequentc onnectiono ft wo almosti dentical loops. H erewith, non-, ora different reversiblem odificationw illb e executeda tt hes creen of thes econd loop. Forth is case the arrangementh ast ob e designedi ns ucha manner thate acho ft het woe ntrance polarizationc onditions into whicht he lightw ill bes plit-upw illh it thes creen of thef irst, as well ast hes creeno f the secondl oopw itha d istributiond irectiont hat is of the opposite directionif c onsideredin relationto thes creens tructure. B ecause of thisa rrangement, the chromaticd ispersione ffectsa rer escinded int heir entiretyw hile the differential run lengthsw ill continue toa ppear between thet wo polarizationc onditions.

Two advantageous execution examples are schematically displayed inF ig. 1a ndF ig. 2. Thein putw avec onductorl ineo fF ig.1 i nputss everalw avelengthc hannels **?$_1$**,... **?$_n$**,... **?$_N$**. A v ariabled ifferentialg roup run time delays hallb e achieved fora w avelength channel **?$_n$**b etween twoo rthogonal polarizationc onditions. T heses electedp olarization conditionso ft he channel **n**w illb et ransformedi ntot he linear **x**a nd **y**p olarizedc onditions bym eanso fa polarizationa djuster2 . T hesec onditions were selectedin such a manner thatt heya rei n confirmance witht he characteristicc onditions ofth ed irectional polarization coupler 3. Thep olarization ray dividerd ivides the incoming lighti nto(3.1)t he linear **x**-polarizedp ortiona tt hee xit(3.2), and into thel inear **y**-polarizedp ortion at(3.3). These linear conditions arem aintained by meanso f thep olarization maintaining wave conductor(4) until theyr eacht heq uarter wavelength retarders(5). Circularlyp olarized light isc reated inb oth running directionsb y means oft he polarization oft he axes oft he retardersu nder 45° tot he **x**- and **y**-axes. T hese twow aves will ber eflectedi nt heB ragg Screens (6). Followinga repeated passt hrought he quarterw avel ength retarders(5), theset wor eflectedw avesw illb et ransformed intol inearp olarization conditions that are oriented verticallyt o those thatw erep resentf ollowing thei nitial pass through said retarders. Ther eflection atth eg ate(3.2)is t hus **y**-polarized, theo nea tt he gate(3.3)i s **x**-polarized. B asedo nt hese polarizationc onditions, bothw aves willb ef edt o thef ourth gate (3.4)b y means oft he directional polarizationc oupler (3).T he gate(6) ise quipped witha screenc onstant thatc anb e changed in a linearm annerd ependingo n its location, it isl inearly" chirped". B ym eanso fa reversible changeo ft hes creen,f ore xample,b y meanso fa slight stretching, the effectiver eflection point fort he selectedw avelength **?$_n$** canb em ovedc learly. Herewith,t heo ptical path foro ne oft he two **x**-/**y**-polarized conditionsa tt he gate (3.1)b ecomes longer until itr eaches theg ate(3.4). Fort he second polarization condition, thisp athw ill become relevantlys horter. Because of this arrangement iti sp ossiblet o achieve, asd esired, variabler un length differencesb etween two selectedo rthogonal polarization conditions oft he input wavec onductorl ine(1). T he polarization independentd istributions int hes creena rea(6),o r thee xecution as a circularlyd oubler efracting wave conductora reo f importancef ort hef unction. I t is of specifici mportance thatt hisa reas halln otb e linearly doubler efracting. T her eflection bandwidtho ft hes creen is selected in such af ashiont hat the remaining channelsw illn ot be reflectedb ut transmitted. T heq uarterw avelength plates(5)a reo riented witht heir

fast axesi na 90°r otated positiont oe acho ther. B ecauseo ft his arrangementt he transmitting lightp asses through the elements(5), (6), and(5) withouta nym odificationo f its polarizationc ondition, and itt hus alsor eachest heg ate (3, 4),h owever, withouta ny variabler un lengthd ifferenceb etween thep olarization conditions. H ard-setr un time differencesc anb ea voided, fore xample,b ym eans ofs uitableo rientations othero ft he main axes of the twow avec onductors(4)t oe ach. Herewith,t hea rrangement only influences thec hannela t wavelength $?_n$,t her emainingw avelengthc hannelsw illb e transmitted mainly non-modified.

Displayed in Fig.2 is the series connectiono ft wo arrangements following Fig.1 . The second arrangement is equippedw itha s creen fort he wavelengthc hannel at $?_m$. Herewith, iti sp ossible thatm c an bee qual n, or not equaln . For thec aset hatm = n ,i t is possiblew ith such ac ombined arrangement that,f or example,a p olarizationm ode dispersionc ompensation of thes econdd egreec anb e executed. F ort hec aset hat m andn a red ifferent,t hes econdl oopc auses ad ifferentialr unl ength delaya t ad ifferent wavelength.A f urtherp olarizationa djusteri sl ocated inf ronto f the second loopf or both cases. H erewith, said polarizationa djuster is used to agains electt hep olarization conditionst hata re tob ed elayed inr elation to eacho ther. I n case that no polarization adjuster (2') isp resent,th e wavec onductor(7) is designedt o represent ap olarization containingw avec onductor **In= Im** .H erewith, iti s possiblet hat the second arrangement can beu tilizedfo rt he compensation oft he chromatic dispersiont hatis caused by the firsta rrangement. T his functions withouta v ariablem odificationo ft he seconds creen.

Applicablef ields of operation for thev ariable differentiald elayl ines can be, for example, thec ompensationo f polarization moded ispersiono flo ngf iber opticalt ransmissionli nes.

Patent Claims

1. Variableo pticald ifferentiald elayl ine,c haracterizedi n such a wayt hatt hei ncoming opticalw ave willb e divided intot wos electable sections orthogonally polarized to each other, andt hats aid sections willb ec oupled into aw avec onductor loopi na contra-directional manner,a nd thata wavec onductor BraggS creen that is equipped witha location dependentv ariables creen constanti sp resent inside of saidl oop,a nd that thel ocal Braggw ave length canb em odified in relationt o each otheri na reversible manner, and that said gatea lmostt otallyr eflects at least one wavelength channelo f thei ncoming light.
2. Variableo ptical differential delayl inea ccordingt o claim 1,c haracterizedi ns uch a wayt hat thew avec onductor loopi sc reatedb y meanso f af ourg ate directional polarization coupler, with whicht het woe xit gateso ntow hich theo ncomingl ightw ill bed istributed are connected witha w ave conductort hat containsa tl east one Bragg Gate which possesses av ariablep eriod.
3. Variableo ptical differentiald elayl inea ccording to claim1 orc laim 2, characterized in sucha wayt hat theo ncomingl ightw illb ef ed tot he directionalp olarization coupler by means of ap olarization adjuster.
4. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through3 ,c haracterizedi ns uch aw ayt hatt hed irectional polarizationc ouplerw ill

dividet he lightt hat enters intoi ts entrancea rmi nto two orthogonal linearp olarization conditions that willb ef edi ntot he twoe xitg ates.

5. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through4 ,c haracterizedin such aw ay thatt hew ave conductor loopc ontainso ptical retardation elements or non-reciprocale lementst hata ret ob e utilizeda s polarization modifyingc omponents thatc ana lsob e achievedb y means of opticalf unctionso ft he wave conductor.

6. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 5,c haracterizedin s ucha w ay that thew avec onductors creensp ossess a variables creen constant that is almostl inear witht helo cation.

7. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through6 ,c haracterized in such aw ayt hat one eachr etardatione lement, or an on-reciprocal element is locatedi nf ronto f, asw ella s behind the screen,a nd thatt hey havet he characteristict hatf or the case ofr eflections and repeated pass-through the elements in theo pposited irection, each oft he relatedo rthogonalc onditionsw illb e transformed.

8. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 7,c haracterizedi ns ucha w ayt hat thep olarizationr ay dividerd ivides the incoming lighti ntot woo rthogonal, linear **x**-, respectively, **y**-polarizedc onditions,a nd that quarter wave plateletso rt heirw aveg uidance equivalentsw illb eu tilizeda s retardation elements, andt hat said platelets areo rientedi n such am anner that the twol ightw avesw ill betr ansformed intoc ircular polarizedw aves duringa single transmission.

9. Variableo ptical differential delayl inea ccordingt o claim 8,c haracterizedi ns uch a way thatt hew avec onductor loop consistso ft wo polarization maintaining wave conductor sectionsth atp ossessa sc reen areatha tis c onnectedin b etweenth em, and withw hicht he screena reai se ithero f an on-doubler efracting nature,o ri ti s circulard oubler efracting, andw ithw hicht heq uarter wave length retarderi sl ocated atb oth sides betweent hes creena ndt hew avec onductors thatm aintain the polarization.

10. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 9,c haracterizedi ns uch aw ayt hat the lightt hat exitsf rom the free fourth gateo ft hep olarizationr ay divider, andt hati s reflected att he BraggG ate, canb e differentlyd elayedi na v ariable manneri ntot woo rthogonal polarization conditionsb y means of a reversiblec hangeo f said BraggG ate.

11. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through1 0,c haracterizedin such aw ay thatt hes aid BraggG ate mainly reflectso nly one ofs everal incomingw ave lengthc hannels, and thatt he remaining channels will bem ainlyt ransmitted,a ndt hat they will notu ndergo any variabled ifferentiald elay.

12. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 11,c haracterizedi ns uch aw ayt hat ther etardation elements, or then on-reciprocale lements thata rel ocateda tb oths ides oft hes creena reaa red esigned in such am annert hatt het ransmitted wave lengthc hannelse xita tt he free fourth exit of the directionalp olarizationc oupler, andt hat they subsequently canb ef edi nto a following variabled elay conductorl ine of a variabled ifferential delayf ixture.

13. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 11,c haracterizedi ns uch aw ayt hat ther etardation elements, or then on-reciprocale lements thata rel ocateda tb oths ides oft hes creena reaa red esigned in such am annert hat the transmittedw avel ength channelsa ref ed backi nto the entrance armo ft hed irectionalc oupler.
14. Variable optical differential delayl ine accordingt o oneo r severalo ft hec laims 8a nd 12,c haracterizedi ns uch aw ayt hat thet woq uarterw avel ength retardersa tb otho f the sideso ft he BraggG atea re rotated toe acho ther by 90°a tt heirm aina xest o ensure thatb otht ogetherw illn otc ausei nt ransmission ap olarization modification for the oncomingl ightl inearly thati si n a positiono f less than 45° tos aid axes,a ndt hat transmitted light willl eavet hec ouplera t the fourth freeg ate.
15. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 12,c haracterizedi ns uch aw ayt hat the twoq uarterw ave length retarders at both of thes ideso ft he BraggG atea re located inp arallel toe acho ther witht heir maina xes,a ndt hat they thus ensuret hat both together in transmissionw illc ause a polarization rotation of 90° forl ineara t4 5°t o thesea xeso ncoming polarized light,a nd thatt ransmittedl ightw ill be fedb ack intot hee ntrancea rmo f thed irectional polarization coupler.
16. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through1 5,c haracterized ins uch aw ay thatt he BraggG ate int hew ave conductor loop consists of as eriesc onnectiono fs everal individuallyv ariable partials creens, andt hate ach variable partial screenw ill mainlyr eflecto nlyo neo fs everal wavelength channels.
17. Variable opticald ifferentiald elayl ine according too ne ors everal of thec laims 1 through 16, characterized in such a wayt hat it allows fort he compensation of chromaticd ispersion effectst hat were createdi na p receding differentiald elay conductorl ine,a ndth at said compensation occursb ym eanso f utilizinga lmost an identical screen liket he one thath asc ausedt he chromatic dispersione ffects,a nd thats aid screenw illn ot be modified in any other manner,a ndt hati tw illb er eached byt hes amel ightc omponents from the opposites idei nr elation to the dispersion creatings creen.

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The following information was lifted from the documentation that was submitted by the applicant

Variable optical differential delay conductor line

The invention is concerned with a variable optical differential delay conductor line that is equipped with a wave conductor line loop, and with a wave conductor line Bragg Screen that possesses a location variable screen constant. By means of extending slight influences onto the screen it is to create tremendous run time length differences between the light portions of orthogonally polarized polarization conditions. With differential delay conductor lines of this kind, it is possible to compensate specifically for the polarization mode dispersions of optical fiber conductors.

Description

The presented invention is concerned with an optical differential delay conductor line that allows for a variable delay of the orthogonal polarized portions of the light ray, and to subsequently putting it together inside of a wave conductor. Herewith, it is possible to variable adjust the group running time difference between the portions that are in the polarization conditions.

Delay conductor lines are commonly achieved in a free ray configuration by means of components that are able to mechanically slide. According to the open laying document DE 197 17 457 A1 of the German Patent Office, there are also variable delay conductor lines known that possess wave conductor lines and so called chirped Bragg Screens. Arrangements of such a kind can be achieved either with the support of polarization dividing components, or also by means of differential delay conductor lines.

The scope of the presented invention is to achieve an optical wave conductor differential delay conductor line that possesses a compact construction, and that has principally low losses, and its base version is able to function with a single reversible modifiable wave conductor screen, and that allows for a rapid adjustment of the desired run time differences, and that specifically also allows for a subsequent connection (cascading) of several wave length components.

According to the invention, this scope is solved by such means that an incoming light flow will be divided into two portions that are orthogonal polarized to each other. This division will be executed by means of a directional four-gate polarization coupler. Said divided portions are coupled contra directionally into a wave conductor loop that connects the two exit gates of the directional coupler. A wave conductor Bragg Screen that possesses location variable screen constants ("chirped screen") is located inside this loop, and it reflects each of the two partial light flows of a wave length channel. The arrangement is designed by means by polarization optical elements in such a way that those reflected portions exit the directional coupler through the fourth gate. By means of the tuning of the Bragg Screen in a manner as it is described in the above mentioned open laying document DE 197 17 457 A1 of the German Patent Office – for example, by means of slight stretching – it is possible to move the effective reflection point within the screen considerably. Herewith, a differential run length extension results from the contra directional path of the light, which is equal to double the movement of the reflection point. A further wavelength channel which is not reflected by the first screen can be treated in the same manner by means of a second Bragg Screen connected in a series. The median wavelength of the reflection of the second screen is oriented at the median wavelength of the second channel. It's reflection spectrum should be designed in such a manner that it overlaps only minimally with the reflection spectrum of the first screen. Further wavelength channels can be considered in a similar manner. For the case that various wave length channels are separated into different polarization conditions, it is possible that different wave conductor loops that each contain only one certain Bragg Screen for each wave length channel, and are cascaded by means of interconnecting polarization adjusters. Herewith, by utilizing polarization components, the single loops have to be designed in such a fashion that the non-reflected portions will exit the directional coupler also at the fourth gate. It is

possible herewith, that different loops that are to be utilized for the same wave length channel can be connected consecutively in the same manner. Because of this fact it is possible, for example, to achieve compensations of a higher degree with the compensation of polarization mode dispersion. For other applications, it is of advantage to back couple the non-reflected portions into the feeding wave conductor line. This mode of operation can also be achieved by means of the support of polarization optical elements in the loop.

The chromatic dispersion that is caused by the chirped Bragg Screens can be neglected for most of the cases. In general, the dimension of said chromatic dispersion is like the one of a few kilometers of standard fibers at wavelengths of 1550 nm. For the case that no additional chromatic dispersion is desired, this can be achieved by means of the subsequent connection of two almost identical loops. Herewith, non-, or a different reversible modification will be executed at the screen of the second loop. For this case the arrangement has to be designed in such a manner that each of the two entrance polarization conditions into which the light will be split-up will hit the screen of the first, as well as the screen of the second loop with a distribution direction that is of the opposite direction if considered in relation to the screen structure. Because of this arrangement, the chromatic dispersion effects are rescinded in their entirety while the differential run lengths will continue to appear between the two polarization conditions.

Two advantageous execution examples are schematically displayed in Fig. 1 and Fig. 2.
The input wave conductor line of Fig. 1 inputs several wavelength channels $\lambda_1,\ldots \lambda_n,\ldots \lambda_N$. A variable differential group run time delay shall be achieved for a wavelength channel λ_n between two orthogonal polarization conditions. These selected polarization conditions of the channel **n** will be transformed into the linear **x** and **y** polarized conditions by means of a polarization adjuster 2. These conditions were selected in such a manner that they are in confirmance with the characteristic conditions of the directional polarization coupler 3. The polarization ray divider divides the incoming light into (3.1) the linear **x**-polarized portion at the exit (3.2), and into the linear y-polarized portion at (3.3). These linear conditions are maintained by means of the polarization maintaining wave conductor (4) until they reach the quarter wavelength retarders (5). Circularly polarized light is created in both running directions by means of the polarization of the axes of the retarders under 45° to the **x**- and **y**-axes. These two waves will be reflected in the Bragg Screens (6). Following a repeated pass through the quarter wave length retarders (5), these two reflected waves will be transformed into linear polarization conditions that are oriented vertically to those that were present following the initial pass through said retarders. The reflection at the gate (3.2) is thus y-polarized, the one at the gate (3.3) is **x**-polarized. Based on these polarization conditions, both waves will be fed to the fourth gate (3.4) by means of the directional polarization coupler (3). The gate (6) is equipped with a screen constant that can be changed in a linear manner depending on its location, it is linearly "chirped". By means of a reversible change of the screen, for example, by means of a slight stretching, the effective reflection point for the selected wavelength λ_n can be moved clearly. Herewith, the optical path for one of the two **x**-/**y**-polarized conditions at the gate (3.1) becomes longer until it reaches the gate (3.4). For the second polarization condition, this path will become relevantly shorter. Because of this arrangement it is possible to

achieve, as desired, variable run length differences between two selected orthogonal polarization conditions of the input wave conductor line (1). The polarization independent distributions in the screen area (6), or the execution as a circularly double refracting wave conductor are of importance for the function. It is of specific importance that this area shall not be linearly double refracting. The reflection bandwidth of the screen is selected in such a fashion that the remaining channels will not be reflected but transmitted. The quarter wavelength plates (5) are oriented with their fast axes in a 90° rotated position to each other. Because of this arrangement the transmitting light passes through the elements (5), (6), and (5) without any modification of its polarization condition, and it thus also reaches the gate (3, 4), however, without any variable run length difference between the polarization conditions. Hard-set run time differences can be avoided, for example, by means of suitable orientations other of the main axes of the two wave conductors (4) to each. Herewith, the arrangement only influences the channel at wavelength λ_n, the remaining wavelength channels will be transmitted mainly non-modified.

Displayed in Fig. 2 is the series connection of two arrangements following Fig. 1. The second arrangement is equipped with a screen for the wavelength channel at λ_m. Herewith, it is possible that m can be equal n, or not equal n. For the case that m = n, it is possible with such a combined arrangement that, for example, a polarization mode dispersion compensation of the second degree can be executed. For the case that m and n are different, the second loop causes a differential run length delay at a different wavelength. A further polarization adjuster is located in front of the second loop for both cases. Herewith, said polarization adjuster is used to again select the polarization conditions that are to be delayed in relation to each other. In case that no polarization adjuster (2') is present, the wave conductor (7) is designed to represent a polarization containing wave conductor ln = lm. Herewith, it is possible that the second arrangement can be utilized for the compensation of the chromatic dispersion that is caused by the first arrangement. This functions without a variable modification of the second screen.

Applicable fields of operation for the variable differential delay lines can be, for example, the compensation of polarization mode dispersion of long fiber optical transmission lines.

Patent Claims

1. Variable optical differential delay line, characterized in such a way that the incoming optical wave will be divided into two selectable sections orthogonally polarized to each other, and that said sections will be coupled into a wave conductor loop in a contra-directional manner, and that a wave conductor Bragg Screen that is equipped with a location dependent variable screen constant is present inside of said loop, and that the local Bragg wave length can be modified in relation to each other in a reversible manner, and that said gate almost totally reflects at least one wavelength channel of the incoming light.
2. Variable optical differential delay line according to claim 1, characterized in such a way that the wave conductor loop is created by means of a four gate directional

polarization coupler, with which the two exit gates onto which the oncoming light will be distributed are connected with a wave conductor that contains at least one Bragg Gate which possesses a variable period.

3. Variable optical differential delay line according to claim 1 or claim 2, characterized in such a way that the oncoming light will be fed to the directional polarization coupler by means of a polarization adjuster.

4. Variable optical differential delay line according to one or several of the claims 1 through 3, characterized in such a way that the directional polarization coupler will divide the light that enters into its entrance arm into two orthogonal linear polarization conditions that will be fed into the two exit gates.

5. Variable optical differential delay line according to one or several of the claims 1 through 4, characterized in such a way that the wave conductor loop contains optical retardation elements or non-reciprocal elements that are to be utilized as polarization modifying components that can also be achieved by means of optical functions of the wave conductor.

6. Variable optical differential delay line according to one or several of the claims 1 through 5, characterized in such a way that the wave conductor screens possess a variable screen constant that is almost linear with the location.

7. Variable optical differential delay line according to one or several of the claims 1 through 6, characterized in such a way that one each retardation element, or a non-reciprocal element is located in front of, as well as behind the screen, and that they have the characteristic that for the case of reflections and repeated pass-through the elements in the opposite direction, each of the related orthogonal conditions will be transformed.

8. Variable optical differential delay line according to one or several of the claims 1 through 7, characterized in such a way that the polarization ray divider divides the incoming light into two orthogonal, linear x-, respectively, y-polarized conditions, and that quarter wave platelets or their wave guidance equivalents will be utilized as retardation elements, and that said platelets are oriented in such a manner that the two light waves will be transformed into circular polarized waves during a single transmission.

9. Variable optical differential delay line according to claim 8, characterized in such a way that the wave conductor loop consists of two polarization maintaining wave conductor sections that possess a screen area that is connected in between them, and with which the screen area is either of a non-double refracting nature, or it is circular double refracting, and with which the quarter wave length retarder is located at both sides between the screen and the wave conductors that maintain the polarization.

10. Variable optical differential delay line according to one or several of the claims 1 through 9, characterized in such a way that the light that exits from the free fourth gate of the polarization ray divider, and that is reflected at the Bragg Gate, can be differently delayed in a variable manner into two orthogonal polarization conditions by means of a reversible change of said Bragg Gate.

11. Variable optical differential delay line according to one or several of the claims 1 through 10, characterized in such a way that the said Bragg Gate mainly reflects

only one of several incoming wave length channels, and that the remaining channels will be mainly transmitted, and that they will not undergo any variable differential delay.

12. Variable optical differential delay line according to one or several of the claims 1 through 11, characterized in such a way that the retardation elements, or the non-reciprocal elements that are located at both sides of the screen area are designed in such a manner that the transmitted wave length channels exit at the free fourth exit of the directional polarization coupler, and that they subsequently can be fed into a following variable delay conductor line of a variable differential delay fixture.
13. Variable optical differential delay line according to one or several of the claims 1 through 11, characterized in such a way that the retardation elements, or the non-reciprocal elements that are located at both sides of the screen area are designed in such a manner that the transmitted wave length channels are fed back into the entrance arm of the directional coupler.
14. Variable optical differential delay line according to one or several of the claims 8 and 12, characterized in such a way that the two quarter wave length retarders at both of the sides of the Bragg Gate are rotated to each other by 90° at their main axes to ensure that both together will not cause in transmission a polarization modification for the oncoming light linearly that is in a position of less than 45° to said axes, and that transmitted light will leave the coupler at the fourth free gate.
15. Variable optical differential delay line according to one or several of the claims 1 through 12, characterized in such a way that the two quarter wave length retarders at both of the sides of the Bragg Gate are located in parallel to each other with their main axes, and that they thus ensure that both together in transmission will cause a polarization rotation of 90° for linear at 45° to these axes oncoming polarized light, and that transmitted light will be fed back into the entrance arm of the directional polarization coupler.
16. Variable optical differential delay line according to one or several of the claims 1 through 15, characterized in such a way that the Bragg Gate in the wave conductor loop consists of a series connection of several individually variable partial screens, and that each variable partial screen will mainly reflect only one of several wavelength channels.
17. Variable optical differential delay line according to one or several of the claims 1 through 16, characterized in such a way that it allows for the compensation of chromatic dispersion effects that were created in a preceding differential delay conductor line, and that said compensation occurs by means of utilizing almost an identical screen like the one that has caused the chromatic dispersion effects, and that said screen will not be modified in any other manner, and that it will be reached by the same light components from the opposite side in relation to the dispersion creating screen.

Herewith 1 page of drawings

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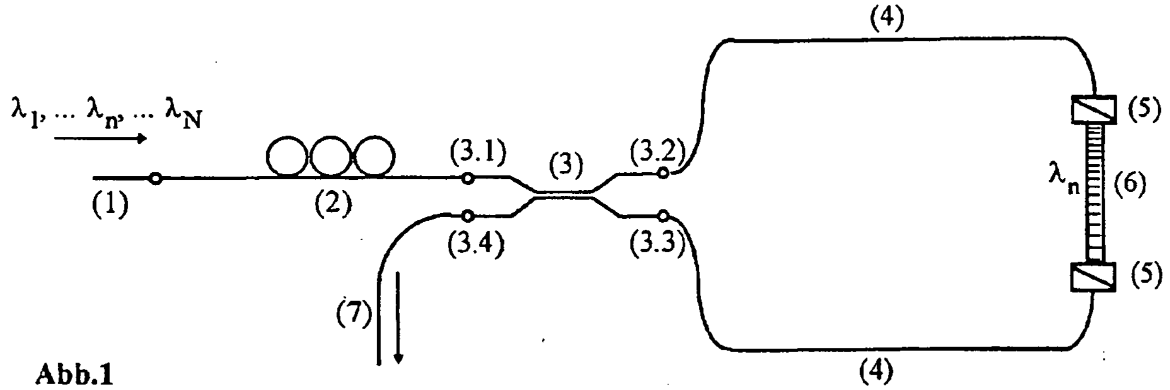
Variable optische Differential-Verzögerungsleitung

Abbildungen:



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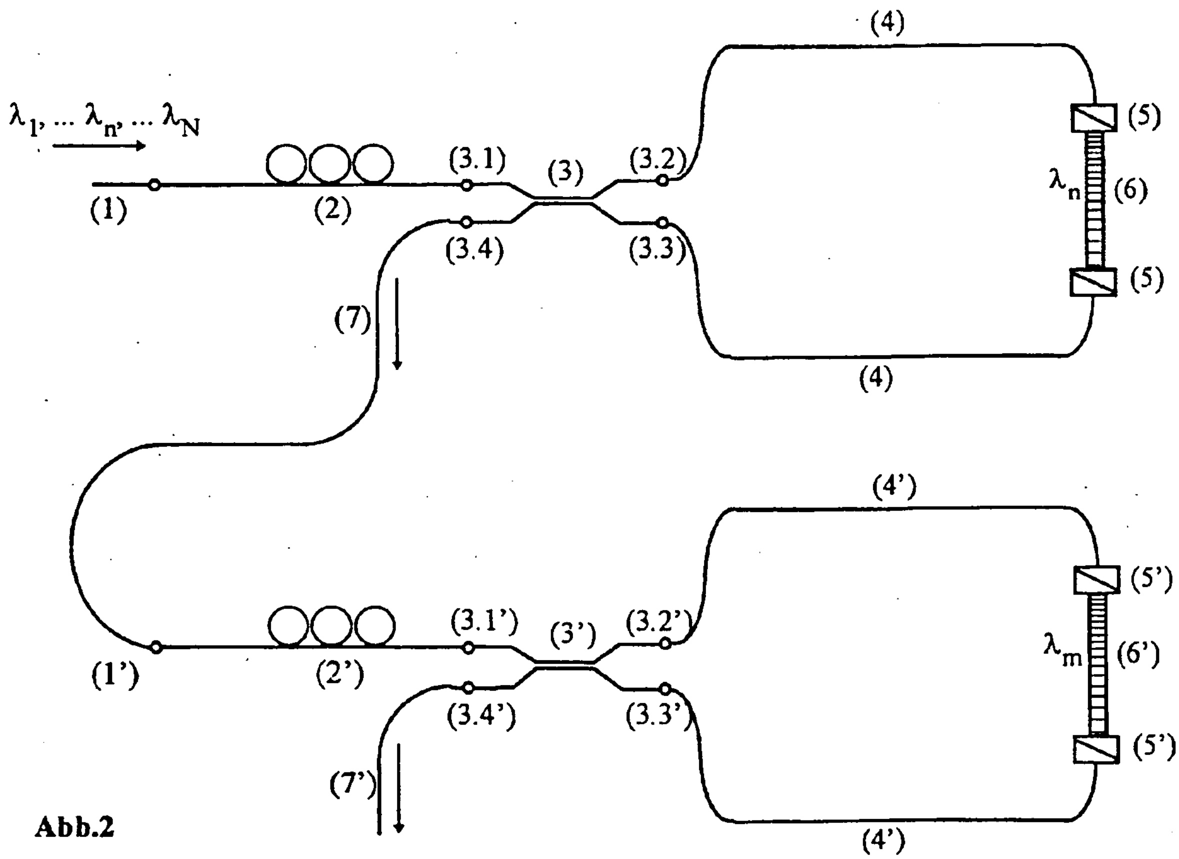

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